

**City of Dillon
Public Water System**

PWSID # MT0000201

***SOURCE WATER DELINEATION AND
ASSESSMENT REPORT***

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INTRODUCTION

Carolyn DeMartino, a Water Quality Specialist with the Montana Department of Environmental Quality, completed the Dillon (PWSID# 00201) Source Water Delineation and Assessment Report (SWDAR). Various sources of information including the draft *City of Dillon PWS Source Water Protection Plan* and the *Hydrogeology of the Upper Beaverhead Basin near Dillon, Montana* by William Uthman and James Beck (December 1998) were used to complete this SWDAR.

Purpose

This Source Water Delineation and Assessment Report is intended to meet the technical requirements for the completion of the delineation and assessment for the Dillon Public Water Supply System (PWSS) as required by the Montana Source Water Protection Program (DEQ, 1999) and the federal Safe Drinking Water Act (SDWA) Amendments of 1996 (P.L. 104-182).

The Montana Source Water Protection Program is intended to be a practical and cost-effective approach to protect public drinking water supplies from contamination. A major component of the Montana Source Water Protection Program is “delineation and assessment”. Delineation is a process of mapping source water protection areas, which contribute water used for drinking. Assessment involves identifying locations or regions in source water protection areas where contaminants may be generated, stored, or transported, and then determining the relative potential for contamination of drinking water by these sources. The primary purpose of this source water delineation and assessment report is to provide information that helps Dillon complete a source water protection plan to protect its drinking water source.

Limitations

This report was prepared to assess threats to the Dillon public water supply, and is based on published information and information obtained from local residents familiar with the community. The terms “drinking water supply” or “drinking water source” refer specifically to the source of the Dillon public water supply and not any other public or private water supply. Also, not every potential or existing source of groundwater or surface water contamination in the Dillon area have been identified. Only potential sources of contamination in areas that contribute water to its drinking water source are considered.

The terms “contaminant” and “toxin” are used in this report to refer to constituents for which maximum concentration levels (MCLs) have been specified under the national primary drinking water standards, and to certain constituents that do not have MCLs but are considered to be significant health threats.

CHAPTER 1 BACKGROUND

The Community

Dillon is located in Beaverhead County in southwestern Montana ([Figure 1](#)). According to the Census Bureau the population of Beaverhead County in 1999 was 8,790 with Dillon's population at 4,342. Dillon's economy is based primarily upon agriculture and tourism. Barretts Minerals Inc., a talc processing facility, and Western Montana College of the University of Montana also contribute to Dillon's economy. Other area businesses include gas stations, automotive dealerships and repair shops, a petroleum bulk plant, the Montana Department of Transportation Maintenance Shop, dry cleaners, restaurants, and motels. Major water users in the community include the college, hospital, and four additional schools. Major waste generators include the college and the hospital.

The major transportation routes in the Dillon area are Interstate 15, U.S. Highway 91, Montana State Highway 41, and Highway 278. Railway transportation is provided by the Union Pacific Railroad.

Dillon is served by a municipal sanitary sewer. The sewage treatment and disposal lagoons are located northeast of town ([Figure 1](#)). The most recent upgrades to the system occurred in 1998 and will allow the system to serve a population of 5,200 into the year 2014. Currently, the system includes four lined aerated treatment ponds and one lined polishing pond with ultraviolet light disinfection. The municipal sewage treatment and disposal system has a permit to discharge to the Beaverhead River. The single discharge point is located at latitude 45°13'50" and longitude 112°37'07". Septic system use continues outside of the Dillon City limits.

There are several additional public water supply systems in the Dillon vicinity ([Figure 2](#)). Although these systems will not be discussed in this report they have been listed in Table 1 for informational purposes.

Table 1. Additional Dillon Area Public Water Supply Systems*

Public Water Supply Name	PWSID#	Class
Hildreth Subdivision #2	02468	Community
Hildreth Subdivision #3	03968	Community
Keller Subdivision #2	02485	Community
Skline Trailer Court	02515	Community
Shady Nook Trailer Court	02484	Community
Western Mobile Home	02171	Community
Barrett's Minerals	02154	Non-Transient Non-Community
Armstead Campground (private)	02942	Transient
Bannack State Park Upper Campground (FWP)	03826	Transient
Barrett's Diversion Dam Campground 1&2 (BOR)	02858	Transient
Beaverhead Campground 1, 2, 3 (BOR)	02773	Transient
Big Sky Truck Stop	03725	Transient
Birch Creek Outdoor Ed Center	03674	Transient
Buffalo Lodge Bar	03140	Transient
Cameahwait Campground East (BOR)	02777	Transient
Cameahwait Campground West (BOR)	03577	Transient

Public Water Supply Name	PWSID#	Class
Crystal Park (USFS)	63651	Transient
Dillon KOA	63651	Transient
Fishing Access Campground (BOR)	03578	Transient
Grasshopper Campground (USFS)	62182	Transient
Horse Prairie Campground 1 & 2 (BOR)	02780	Transient
Lewis & Clark Campground (BOR)	02779	Transient
Lone Tree Campground	02778	Transient
Ned Eva Bowling Center	02532	Transient
Price Creek Campground	04053	Transient
Red Mountain Campground BLM	04024	Transient
Southside RV Park Well #1	02153	Transient
Southside RV Park Well #2	03596	Transient
Wade Lake Hill Top Cliff Campground (USFS)	62200	Transient
Town Pump #0360	03318	Transient
Safeway #1581	03815	Purchased

Note: Bureau of Land Management (BLM), Bureau of Reclamation (BOR), U.S. Forest Service (USFS), and Fish, Wildlife, & Park (FWP) Source Water Delineation and Assessment Reports are being completed under separate contracts.

Geographic Setting

Dillon is located along the Beaverhead River in Sections 18 and 19, Township 7 South, Range 8 West, and in Sections 13 and 24 T. 7 S, R. 9W. ([Figure 1](#)). Climate in the Dillon area is considered semi-arid and is typical of western Montana intermontane basins. Average daily high and low temperatures in Dillon are 83.1° F and 47.5° F in July and 34.4° F and 12.3° F in January. Annual precipitation averages 13.4 inches. Rainfall occurs April through September with May and June being the wettest months. An annual average of 42.6 inches of snow is received in the Dillon area mainly November to April (Western Regional Climate Center, Monthly Climate Summary 1/15/1895 to 7/31/2000).

The Beaverhead River originates at the confluence of the Red Rock River and Horse Prairie Creek, located approximately 23 miles southwest of Dillon. The Beaverhead River flows through the narrow, steep-walled Beaverhead Canyon for about 15 miles before entering the upper Beaverhead basin at Barretts Dam. Near Dillon, the Beaverhead River is joined by Blacktail Deer and Rattlesnake Creeks, its major tributaries in the upper Beaverhead Basin (W. Uthman and J. Beck, 1998). The Beaverhead River floodplain is flanked by dissected alluvial fans along the basin margins. The U.S. Geological Survey (USGS) hydrologic unit code (HUC) for the Beaverhead sub-basin of the Upper Missouri River Watershed is 10020002.

Blacktail Deer Creek Valley originates in the Snowcrest Range and extends northwest for approximately 40 miles. Blacktail Deer Creek meanders across a narrow floodplain along the northeast side of the Blacktail Range to Sheep Creek where it emerges onto an alluvial fan/alluvial plain complex that gently slopes northwest toward the Beaverhead River.

Rattlesnake Creek Valley originates in the southern Pioneer Mountains. The valley extends approximately 22 miles southeast from where its headwaters originate. Rattlesnake Creek eventually discharges to the Beaverhead River approximately 11 miles southeast of the town of Argenta.

Clark Canyon Dam and Clark Canyon Reservoir, created to serve irrigation needs in the Beaverhead River Valley, are also located at the confluence of the Red Rock River and Horse Prairie Creek. Many irrigation

diversions exist between Barretts Dam and Dillon. The East Bench Irrigation District Canal maintained by the East Bench Irrigation District of Dillon is the largest diversion on the Beaverhead River.

Dillon is surrounded by four mountain ranges. The Pioneer Mountains are northwest of Dillon, the Ruby Range is to the east, the Blacktail Deer Range and Tendoy Mountains are to the southwest, and the Snowcrest Range is to the southeast.

General description of the Source Water

There are three principal aquifers in the Upper Beaverhead Basin. They include the bedrock aquifer, the lower Tertiary aquifer, and the Quaternary /upper Tertiary valley-fill aquifer (Uthman and Beck, 1998). The Quaternary /upper Tertiary aquifer is named this way because the units behave similarly as water-bearing material although they are different ages and they appear to grade into each other. Table 2 contains the names of geologic or hydrologic investigations that were referenced for this SWDAR. The City of Dillon obtains its water from four wells completed in the Quaternary/upper Tertiary aquifer. The aquifer is composed of Quaternary fluvial and glacial sediments and Tertiary alluvial fan sediments. This aquifer is the most productive and utilized aquifer in the Upper Beaverhead Basin in terms of groundwater yield to area wells. While the aquifer is several hundred feet thick in portions of the basin, it thins to about 25 feet near Dillon. The bedrock aquifer provides only small yields to individual wells. Recharge to the bedrock aquifer in the form of snowmelt and precipitation falling on the mountains provides significant groundwater recharge to the Quaternary/upper Tertiary valley-fill aquifer. Other forms of recharge to this aquifer include direct precipitation, irrigation return flow, and losses from area streams.

Table 2. List of geologic or hydrogeologic investigations near the Dillon area.

Title of Project	Period of Project	Area Covered	Project Purpose
Hydrogeology of the Upper Beaverhead Basin near Dillon, Montana	1991-1996	The Upper Beaverhead Basin between Dillon and Barretts, including the major tributary valleys of Blacktail Deer and Rattlesnake creeks.	To assess the effects of groundwater withdrawals on groundwater levels and streamflow in the Beaverhead River prior to issuance of any new groundwater irrigation permits.
Draft City of Dillon PWS Source Water Protection Plan	1999	Dillon Area	To create a source water protection plan for Dillon

The Public Water Supply

Dillon's PWS provides water to approximately 4,039 residents through 1,733 active service connections. Each service connection is metered. The water supply system consists of the distribution system (Source 001), Well 3 Office Building (Source 002, Entry Point-EP 502), Well 1 East (Source 003, EP-503), Well 2 West (Source 004, also EP-503), and Well 4 N. California (Source 006, EP 506). [Figure 3](#) indicates the locations of the four wells. The most recent sanitary survey (Appendix D) indicates that each well is enclosed in a separate well house along with a vertical turbine pump (D. Fraser, 2001). A detailed description of each well is provided in Chapter 2, Delineation. Well logs for each well are located in Appendix B.

Water treatment for Dillon's water supply is provided by two water treatment facilities. Treatment Facility 1 is located directly north of West Well 2. Water is disinfected with liquid sodium hypochlorite and is also blended with orthophosphosphate (TPC 632S) for corrosion control prior to entering the Dillon PWS distribution system. Treatment Facility 2 is located at Well 4 on N. California Street. Water is disinfected using solid calcium hypochlorite pellets and blended orthophosphate (R. Cottom, June 2002). Currently, water from Well 3 is not disinfected.

Water storage for Dillon's PWS is provided by the 1,000,000-gallon cement reservoir located west of Dillon wells 1 and 2 and the 750,000-gallon East Reservoir. A former 340,000-gallon ground level concrete storage reservoir is inactive due to leakage and will be demolished in the future.

In the past, Dillon also obtained water from an intake located in Rattlesnake Creek. The water was treated with chlorine. Currently, both the Rattlesnake Creek intake and treatment facility are inactive. Because the water would require filtering there are no plans to use this source other than for an emergency water source.

Most of Dillon's water mains were installed from the 1920's to the 1950's. Piping for the distribution system consists mainly of 6-inch to 16-inch diameter cast iron pipe. Other types of materials such as transite and PVC were used for repairs or for new installations in recent years. A pressure of 76 psi is maintained throughout town. The water system layout is available upon request from DEQ.

Water Quality

Dillon's water quality is routinely monitored for compliance with drinking water standards. Bacteriological monitoring is conducted monthly. Compliance with other drinking water standards is based on additional sampling on a variety of schedules. Within the past five years there have been no coliform bacteria detections in Dillon's PWS. Nitrate plus nitrite as nitrogen ranging from 0.17 milligrams per liter (mg/L) to 2.2 mg/L has been detected in Dillon's water within the past five years but remains well below the maximum contaminant level of 10 mg/L (DEQ SDWIS database).

Based on monitoring results, the quality of groundwater in the Upper Beaverhead Basin is very good. Hardness and total dissolved solids appear to be the most frequently elevated parameters. Geochemistry of groundwater within the basin indicates that there are three predominant groundwater types including: 1) calcium-bicarbonate groundwater in the Blacktail Deer Creek Valley and calcium-sodium-bicarbonate water in the Quaternary alluvium of the Beaverhead River floodplain, 2) calcium-bicarbonate-sulfate groundwater within the Blacktail Range alluvial fans and the Flynn Lane area, and 3) calcium-bicarbonate-sulfate groundwater from wells drilled into the deeper Tertiary sediments that also exhibits higher concentrations of sodium and potassium (Uthman and Beck, 1998).

Concentrations of many of the parameters were greater in the Quaternary alluvium of the Beaverhead River floodplain than in the Blacktail Deer Creek valley because the low land floodplain serves as a collection area for mineral concentrations (Uthman and Beck, 1998). Greater amounts of sulfate in the alluvial fan deposits and in the Tertiary sediments indicated that recharge water is potentially coming from the Madison Limestone.

Table 3 contains a summary of Dillon Area Water Quality compiled from the Montana Bureau of Mines and Geology Ground Water Information Center.

Known areas of groundwater contamination in Dillon include fuel releases from leaking underground fuel storage tanks. These potential sources of contamination will be discussed in greater detail in Chapter 3 Inventory and Chapter 4 Susceptibility Assessment.

Table 3. Dillon Area Water Quality Data

Well Name	Total Depth (feet)	Well Depth (feet)	Sample Date	Ca	Mg	Na	K	Fe	Mn	SiO ₂	HCO ₃	CO ₃	Cl	SO ₄	NO ₃ -N	F	OPO ₄
Dillon Well #3 (Source ID# 002)	60.0	20.0	08/21/91	92.0	27.0	23.0	5.7	0.01	<0.01	26.0	315.78	0	0	95	NR	0.30	NR
Dillon Well #1 (Source ID# 003)	124	NR	08/22/91	89.0	26.0	21.0	5.2	0.01	<0.01	28.0	268.20	0	17	130	NR	0.60	NR
BGS Well 92-17	400.0	315.5	08/23/93	37.5	5.5	55	13.2	0.03	0.03	73.5	230.00	0	6.7	59.1	0.18	0.65	<0.15
BGS Well 92-18	79.3	74.0	08/23/93	88.0	25.6	19.2	6.6	0.04	0.00	35.7	307.00	0	13.9	98.6	0.91	0.36	<0.15
BGS Well 92-28	84.8	76.0	08/27/93	65.0	15.8	13.3	4.3	0.13	0.02	38.7	210.00	0	11.8	72.0	1.77	0.28	<0.15
BGS Well 92-29	19.8	17.5	08/27/93	87.9	22.2	22.1	4.3	0.15	0.01	24.8	290.00	0	17.2	90.8	2.58	0.45	<0.15
Dillon Well #3 (Source ID# 002)	60.0	20.0	09/21/95	93.4	29.0	23.1	6.2	<0.003	<0.002	28.0	329.88	0	20	100	2.25	0.40	<0.10
Dillon Well #4 (Source ID# 006)	80.0	20.0	09/21/95	94.2	29.1	24.6	6.7	<0.003	<0.002	30.1	336.70	0	20	100	2.5	0.40	<0.10
Dillon Well #2 (Source ID# 004)	84.0	50.0	09/21/95	93.3	30.5	6.6	5.8	<0.003	<0.002	28.3	284.40	0	20	150	1.5	0.70	<0.10
DWP-1	120.5	NR	04/10/96	52.9	14.1	19.3	4.4	0.02	0.21	24.5	233.50	0	<10	45	0.44	0.63	<2.5

Note: All wells with the exception of BGS Well 92-17 are located in alluvium, BGS Well 92-17 is located in Tertiary Sediments

BGS - Beaverhead Groundwater Study

DWP - Dillon Wellhead Protection

Ca-Calcium, Mg-Magnesium, Na-Sodium, K-Potassium, Fe-Iron, Mn-Manganese, SiO₂-Silica, HCO₃-Bicarbonate, CO₃-carbonate, Cl-Chloride, SO₄-Sulfate
 NO₃-N-Nitrate as Nitrogen, F-Fluoride, OPO₄-Ortho Phosphate

(Information obtained from Montana Bureau of Mines and Geology Ground Water Information Center)

CHAPTER 2 DELINEATION

The source water protection area, the land area that contributes water to Dillon's PWS wells, is identified in this chapter. The management areas identified within the source water protection area included the control zone, inventory region, surface water buffer, and recharge region. The control zone is an area at least 100-foot radius around the well. The management goal of the control zone, also known as the exclusion zone, is to protect against the direct introduction of contaminants into the wells or in the immediate area surrounding each well. The inventory region represents the zone of contribution of the well, which approximates a three-year groundwater time-of-travel. Analytical equations describing ground water flow using estimates of pumping and aquifer characteristics, and simple hydrogeologic mapping are used to calculate groundwater time-of-travel distance (Appendix C). The management goal of the inventory region is to focus on pollution prevention activities at potential contaminant sources where it is likely that contaminated water would flow into the wells within a relatively short time-frame. A surface water buffer zone has been delineated around the Beaverhead River and its major tributaries to account for the interaction of surface water and groundwater. The surface water buffer includes ½-mile buffers around associated surface waters for 10 miles upstream of the groundwater zone of contributions or to watershed limits, whichever distance is shorter. The management goal of the surface water buffer is to protect against the introduction of pathogens and nitrates into the wells through surface water-groundwater interaction. The recharge region represents the entire portion of the aquifer that contributes water to the Dillon water system. Management in the recharge region should focus on maintaining and improving the quality of groundwater that could reach each well over longer timeframes or with increased water usage.

Hydrogeologic Conditions

Much of the following description of the hydrogeologic setting in this section was obtained primarily from the *Hydrogeology of the Upper Beaverhead Basin near Dillon, Montana* by William Uthman and James Beck. Table 4 contains a summary of geologic and hydrogeologic maps available in the Dillon area.

Table 4. List of geologic or hydrogeologic maps available for the Dillon area.

Title or Description	Date	Area Covered	Reference
Dillon West USGS 7.5' Topographic Quadrangle	Photorevised 1979	Dillon Vicinity	USGS 7.5' Topographic Quadrangle
Dillon East USGS 7.5' Topographic Quadrangle	Photorevised 1979	Dillon Vicinity	USGS 7.5' Topographic Quadrangle
Geologic Map of Dillon 1°x 2° quadrangle	1993	Dillon, MT and portion of Idaho	Ruppel, E.T. et al. USGS , Map I-1803-H

The Upper Beaverhead Basin, comprised of the Beaverhead River floodplain and its two major tributaries Blacktail Deer and Rattlesnake Creeks, is thought to be of Miocene age (Figure 4). The floor of the Beaverhead basin is composed of 2.5 to 3.8 billion-year-old metamorphic rocks that are overlain by thick sequences of Tertiary-aged sediments and Quaternary fluvial and glacial sediments (Figure 5). The basin ranges in thickness from 5,000 feet thick at the lower most end (northern end) to 1,500 feet to 3,000 feet thick at the upper end along the Blacktail Fault. The Blacktail Range and the northwest trending Blacktail fault form the southern boundary of the basin. Blacktail fault dips steeply to the southwest. The Ruby Range and Ruby fault form the eastern boundary of the basin, and the western boundary of the basin is formed by the Pioneer Mountains.

The three principal aquifers in the upper Beaverhead basin include the bedrock aquifer, the lower Tertiary

aquifer, and the Quaternary/upper Tertiary aquifer (Figure 5). The bedrock aquifer is present within the mountains surrounding the basin and extends beneath the valley fill. Yield to wells from the bedrock aquifer is low, but the total amount of groundwater recharge to the valley-fill sediments is significant. The lower Tertiary aquifer overlies the bedrock aquifer and is buried beneath the younger, coarser sediments. It is comprised of mainly fine-grained sediments. While this aquifer may be up to 3,000 feet thick in the upper portion of the basin, it also has low yield to wells because there are finer sediments. The Quaternary/upper Tertiary aquifer composed of fluvial and glacial sediments ranges in total thickness from tens of feet to hundreds of feet thick. It is the most productive and most utilized aquifer in the Upper Beaverhead Basin. The aquifer thins to 25 feet northeastward in the Dillon area (Figure 5).

Uthman and Beck, (1998) divided the basin further into the following areas: the Upper Blacktail Creek Valley, Blacktail Range Alluvial Fan, Flynn Lane Well Field area, Middle Blacktail Deer Creek Valley, Lower Blacktail Deer Creek Valley, Beaverhead River Floodplain near Barrets, Lower Rattlesnake Creek Valley, and Beaverhead River Floodplain near Dillon. The Beaverhead Groundwater Study conducted from 1991 to 1996 compared stream elevations with the groundwater elevations in wells and piezometers located along the Beaverhead River. The study verified that surface water and groundwater in the Upper Beaverhead Basin appear to be interconnected. The following table is used to determine source water/ aquifer sensitivity.

Source Water Sensitivity
High Source Water Sensitivity Surface water and GWUDISW Unconsolidated Alluvium (unconfined) Fluvial-Glacial Gravel Terrace and Pediment Gravel Shallow Fractured or Carbonate Bedrock
Moderate Source Water Sensitivity Semi-consolidated Valley Fill sediments Unconsolidated Alluvium (semi-confined)
Low Source Water Sensitivity Consolidated Sandstone Bedrock Deep Fractured or Carbonate Bedrock Semi-consolidated Valley Fill Sediments (confined)

Dillon's wells are completed in Quaternary/upper Tertiary alluvium. Generally, the Quaternary/ upper Tertiary aquifer is unconfined. It is comprised mainly of fluvial and glacial cobbles, gravel, sand, and silt. Although the aquifer may be locally cemented, sequences of silts and clays that may locally separate and confine coarse-grained deposits are usually discontinuous and hydraulically connected with more permeable materials. Based on this information and the information contained in the Source Water Sensitivity Table, the aquifer that supplies water to Dillon's wells has a high sensitivity to potential contaminant sources.

Conceptual Model and Assumptions

Groundwater within the Quaternary/ upper Tertiary alluvium is the source of water for Dillon's four wells. The Quaternary/upper Tertiary aquifer is composed of fluvial and glacial sediments that ranges in total thickness from tens of feet to hundreds of feet thick. It is the most productive and most utilized aquifer in the Upper Beaverhead Basin. The aquifer thins to 25 feet northeastward in the Dillon area. Three major groundwater flow direction patterns have been identified in the Upper Beaverhead Basin. Groundwater flow direction in the Blacktail Deer Creek Valley is northwest, in the Rattlesnake Creek Valley it is southeast, and from Barretts Dam toward Dillon along the Beaverhead River floodplain it is northeast (Figure 6). A significant source of recharge to the alluvial aquifer is from precipitation falling on the mountains

surrounding Dillon and from snowmelt. Other sources of recharge to the alluvial aquifer include direct precipitation, irrigation return flow, and losses from area streams.

During summer months, streamflow appears to be greater in the Beaverhead River at Barretts Dam than at Dillon. This is due to large amount of water being withdrawn from the river in the Dillon area for irrigation. Between Barretts Dam and the I-15 exit at Highway 278, the Beaverhead River is a losing stream providing water to the aquifer. From the I-15 exit at Highway 278, north to Dillon the Beaverhead River is a gaining stream with groundwater being discharged from the aquifer to the river. When irrigation is not being utilized greater stream flow occurs in the Dillon area.

Generally, groundwater is at its lowest in late April or early May and highest during July and August. Seasonally, groundwater level rises of 5-15 feet have been measured near Barretts Dam, in the Rattlesnake Creek Valley, and in the Blacktail Deer Creek Valley. Groundwater level rises along the Beaverhead River near Dillon have been measured at less than one-foot to five feet. Because the aquifer thins northeastward groundwater levels are higher in this area.

Well Information

Data for Dillon's four wells is summarized in Table 5. A more detailed description of each PWS well follows.

Table 5. Source well information for the Dillon PWS.

Information	Well #1 (East)	Well #2 (West)	Well #3	Well #4
PWS Source Code	003	004	002	005
Well Location (T, R, Sec)	T7S, R9W, 23 BDAA	T7S, R9W, 23BDAA	T7S, R8W, 18CDCC	T7S, 8W, 19BADD
Latitude/ Longitude	45.2136/ 1126722	45.2141/ 112.6704	45.2186/1126347	45.2154/ 112.6297
MBMG #	149185	151329	109444	151327
Water Right #	W088185	W088186	W088187	W00088188
Date Well was Completed	03/26/48	01/01/60	03/02/63	06/20/73
Total Depth	124'	83.50	60'	80'
Perforated Interval	NA	50-70'	20-46'	20-33' 64-72'
Static Water Level	35'	46'	17'	9'
Pumping Water Level	NA	70'	24'	41'
Drawdown	NA	24'	7'	32'
Test Pumping Rate	NA	550 GPM	1000 GPM	1130 GPM
Specific Capacity	NA	22.92'	142.86'	35.31

Well 1 East: was drilled in 1948 and is located in a well house west of Dillon at 1405 Ten Mile Road. The well is constructed of 10-inch diameter steel casing and is 124-feet deep. No annular seal records are available for Well 1. The well is equipped with a 50 H.P. pump that delivers water at a rate of 500 gpm. The average production rate for this well is 510,000 gallons per day (gpd) and the maximum production rate is 720,000 gpd.

Well 2 West: was drilled in 1960 and is located in a well house just west of West Well 1 at 1405 Ten Mile Road. The well is constructed of 12-inch diameter steel casing to a depth of 83.50 feet. No annular seal records are available for Well 2. This well has a 40 H.P. vertical turbine pump that delivers water at a rate of approximately 500 gpm. The average production rate for well 2 West is 510,000 gallons per day and the maximum production rate is 720,000 gpd.

Water treatment for Well 1 East and Well 2 West is provided in the building directly north of Well 2 West. Water from the two wells mixes at a common header prior to entering the treatment building. Water is pumped from the building where sodium hypochlorite is added for disinfection for the 1.0 million-gallon cement reservoir. Water flows by gravity flow from the reservoir back through the treatment building where orthophosphate is added for corrosion control prior to entering the city's distribution system.

Well 3 (Office building well): was drilled in 1963 and is located in a well house on the corner of Helena and N. Idaho. This well is used only during the summer months. The well is constructed of 14-inch diameter steel casing to a depth of 50 feet. Annular seal records are not available for this well. The well is equipped with a 75 H.P. pump that delivers water at a rate of 1,000 gpm. This well is also equipped with a 100 H.P. direct drive diesel engine that can be used if there is a failure. There is no water treatment information available for Well 3. The average production rate for this well is 450,000 gpd and the maximum production rate is 1,440,000 gpd.

Well 4 was drilled in 1973 and is located in a well house on North California between East Center and East Bannack Streets. The well is constructed of 16-inch steel casing to a depth of 80 feet. There are no annular seal records for Well 4. The well is equipped with a 40 H.P. high thrust vertical turbine pump that delivers water at a rate of approximately 500 gpm. Water treatment for Well 4 N California is provided via a hypochlorite feeder line that returns pressurized system water through the solid calcium hypochlorite pucks back down the well casing where the water is then injected with orthophosphate. An average production rate for well 4 was not indicated in the most recent sanitary survey but the maximum production rate indicated was 220,000 gpd.

Methods and Criteria

DEQ's Source Water Protection Program specifies methods and criteria used to delineate subregions of the source water protection area for Dillon's wells. One hundred-foot radius control zones were delineated around each well. Hydrogeologic mapping and time-of-travel (TOT) equations describing uniform groundwater flow were used to delineate the one-year and three-year TOT inventory regions for Dillon's wells ([Figure 7](#), Appendix C). The inventory region boundary delineates the distance in the aquifer that would be traveled by water or contaminants in approximately three years. The stagnation point and boundary limit delineate the down gradient and lateral extent of the capture zone for the Dillon wells (Appendix D). A separate surface water buffer for the Beaverhead River and its major tributaries was not delineated because the inventory region was expanded to include the surface water buffer.

Time-of-Travel Model Input

Estimates of the input parameters for the Dillon wells were obtained from the well logs, previous reports, hydrogeology texts, and personal communication with the Dillon water supply operator. Estimates of these parameters are summarized in Table 6. The selection criteria for the parameters are described in the text following Table 6.

Table 6. Estimates of input parameters used to delineate the source water protection area.

Input Parameter	Range of Values/ Units	Values Used (for each well if more than one)			
		Well #1	Well #2	Well #3	Well #4
PWS Source Code	N/A	003	004	002	005
Transmissivity	$1 \times 10^4 - 1 \times 10^5$ ft ² /d	11,895	6,120	57,940	43,323
Thickness	15-21 Feet	15	20	20	21
Hydraulic Conductivity	$1 - 10^4$ ft/d	793	306	1750	2100
Hydraulic Gradient	.003 - .012	.003	.003	.012	.008
Flow Direction	N-NE	NE	NE	N	N
Effective Porosity	15 -20 %	.15	.15	.15	.15
Pumping Rate	500 - 1000 GPM	500	500	1,000	500
1-Year TOT*	1-5 Miles	1.35	.8	3.4	4
3-Year TOT*	1-15 Miles	3.6	1.8	10	12

*Time of Travel

PWS Source Code - is the specific identification code for each Dillon PWS well. The code is obtained from the DEQ Public Water Supply Section SDWIS database.

Transmissivity (T) - is the rate of groundwater flow through an aquifer cross-section of unit width over the entire saturated thickness of the aquifer under a unit hydraulic conductivity.

Thickness - denotes the aquifer thickness that was indicated on the well logs.

Hydraulic Conductivity (K) - is the rate at which a porous material (e.g. sand and gravel) transmits water.

Hydraulic Gradient (i) is the change in water level over distance. The value for the hydraulic gradient was obtained from the Uthman and Beck report (December 1998).

Flow Direction - is the direction that ground water is flowing. This information was obtained from Figure 11 of the Uthman and Beck report (December 1998).

Effective Porosity - as applied to aquifer materials it is the ratio of the volume of water which, after being saturated, the aquifer will yield by gravity to its own volume. The value was obtained from the draft City of Dillon PWS Source Water Protection Plan (January 1999) and from Driscoll (1986).

Pumping Rate - is the pumping rate of Dillon's wells. This information was obtained from the most recent sanitary survey.

1-Year TOT - is calculated. See TOT Calculation Table in Appendix C.

3-Year TOT - is also calculated. See TOT Calculation Table in Appendix C.

Delineation Results

One-year TOT and three-year TOT distances were calculated for Dillon's wells ([Figure 7](#)). Because the distance groundwater travels in these time frames is so great within the Quaternary/upper Tertiary aquifer, the four municipal wells were grouped together. A combined three-year TOT travel distance of 10 miles and a combined one-year TOT distance of approximately 3 miles was utilized for the wells.

Limiting Factors

This delineation is based on estimated groundwater flow and pumping conditions. Uncertainty exists concerning the vertical and lateral extent of potential confining layers. Also, the total amount of recharge to the system from streams and irrigation canals is unknown and can vary seasonally. To account for some of this variation, the inventory region was expanded to valley walls.

Time of travel distances represent the time required for ground water to travel through a specified aquifer to the public water supply well. These distances do not represent the time required for contaminants to reach a public water supply well. Travel times for the migration of free phase contaminants that are not dissolved in the ground water vary tremendously from ground-water travel times. Free phase contamination migration rates are influenced by the characteristics of the vadose zone, contaminant density, the slope of the water table, the slope of the base of the aquifer, aquifer porosity, lithologic heterogeneities, and the extent and duration of contamination.

Travel times for dissolved contaminant migration also differ from ground-water travel times. Dissolved contaminants are affected by advection, or the component of solute movement attributed to transport by flowing ground water (Freeze and Cherry, 1979). However, the migration of dissolved contaminant plumes is also affected by many additional factors, including the characteristics of the vadose zone, the extent and duration of contamination, contaminant solution density, mechanical dispersion, biological transformation, dilution, molecular diffusion, adsorption, precipitation, oxidation, complexation, volatilization, radioactive decay, lithologic heterogeneities, and water extraction.

Inventory regions delineated using time-of-travel calculations should be used as a planning tool to identify areas within which the potential for contaminants to reach a public water supply source is highest. Ground-water time-of-travel calculations should not be used to estimate contaminant migration rates.

CHAPTER 3 INVENTORY

An inventory of potential contaminant sources was conducted within the Dillon PWS well control zones, and inventory region, and recharge region. Potential sources of all primary drinking water contaminants and Cryptosporidium were identified, however, only significant potential contaminant sources were selected for the detailed inventory. Significant potential contaminants in the Dillon inventory region include nitrate, pathogens, fuels, solvents, agricultural chemicals, and metals.

The potential contaminant source inventory for Dillon focuses on all activities in the control zone, certain sites or land use activities in the inventory region, and general land uses and large facilities in the recharge region.

Inventory Method

Available databases were initially searched to identify businesses and land uses that are potential sources of regulated contaminants in the inventory region. The following steps were followed:

Step 1: Urban and agricultural land uses were identified using the United States Geological Survey National Landcover Dataset 2000.

Step 2: EPA's Envirofacts System was queried to identify EPA regulated facilities. This system accesses the following databases: Resource Conservation and Recovery Information System (RCRIS), Biennial Reporting System (BRS), Toxic Release Inventory (TRI), Permit Compliance System (PCS), and Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS). The available reports were browsed for facility information including the Handler/Facility Classification to be used in assessing whether a facility is a significant potential contaminant source.

Step 3: DEQ databases were queried to identify Underground Storage Tanks (UST), hazardous waste contaminated sites, landfills, and abandoned mines.

Step 4: A business phone directory was consulted to identify businesses that generate, use, or store chemicals in the inventory region. Equipment manufacturing and/or repair facilities, printing or photographic shops, dry cleaners, farm chemical suppliers, and wholesale fuel suppliers were targeted by SIC code.

Step 5: Major road and rail transportation routes were identified.

Step 6. All significant potential contaminant sources were identified in the inventory region and land uses and facilities that generate, store, or use large quantities of hazardous materials were identified within the recharge region.

Potential contaminant sources are designated as significant if they fall into one of the following categories:

- | | |
|--|---|
| 1) Large quantity hazardous waste generators | 8) Wastewater lagoons or spray irrigation |
| 2) Landfills | 9) Septic systems |
| 3) Hazardous waste contaminated sites | 10) Sewered residential areas |
| 4) Underground storage tanks | 11) Storm sewer outflows |
| 5) Major roads or rail transportation routes | 12) Floor drains, sumps, or dry wells |
| 6) Cultivated cropland | 13) Abandoned or active mines |
| 7) Animal feeding operations | |

Inventory Results/Control Zone

Dillon Wells 1 and 2 are located approximately 1.5 miles west of town. Land cover in this area is mainly shrubland and grassland ([Figure 8](#)). None of the listed significant potential contaminant sources are located within these well control zones. Wells 3 and 4 are located in Dillon and surrounded by residential areas and commercial businesses. Streets and sewer mains are located within the 100-foot control zones of these wells ([Figure 9](#)).

Inventory Results/Inventory Region

Land cover within the inventory region for the Dillon PWS includes pasture/hay, small grains, row crops, grassland, shrubland, wetlands and open water, residential land/parks, and commercial/ industrial/ transportation land ([Figure 8](#)). Approximately 74 percent of the inventory region is comprised of agricultural land. Mismanagement or over application of fertilizers and/or pesticides pose a potential threat to the Dillon PWS, due to the large portion of the inventory region over which fertilizers and/or pesticides may be applied. The principal land covers in the inventory region are grasslands, small grains, and fallow ground.

Significant potential contaminant sources in the inventory region are listed in Table 6 and indicated on [Figure 9](#). Table 6a in Appendix D contains a list of all identified potential contaminant sources within the inventory region. Dillon businesses that Bob Cottam and others inventoried during the completion of the draft City of Dillon PWS Source Water Protection Plan are also identified in Appendix D. [Figure 10](#) shows an enlarged portion of the inventory region within the 1-year TOT to indicate the potential contaminant sources in this area better.

Septic system densities within the Dillon PWS inventory region pose a low hazard for wells 1 and 2, and a moderate hazard for wells 3 and 4 ([Figure 11](#)). Essentially, the Dillon municipal sewer system poses no hazard to Wells 1 and 2 in the event of a main break or leaking connections due to the distance of these wells away from Dillon. Municipal sewer lines and utility corridors pose a high hazard to Wells 3 and 4 due to their proximity to the wells. The sewer lines and utility corridors may constitute preferred contaminant migration pathways.

Concentrated animal feeding operations are located within the 3-year TOT inventory region and pose a low hazard to the Dillon wells. The former Beaverhead County Landfill is located within the inventory region north of Wells 1 and 2. The Beaverhead River is a losing stream in this area. Groundwater appears to flow to the north and the former landfill does not pose a threat to these wells because it is located north and downgradient of the wells (Damschen & Associates, Inc., 1996). Dillon's wastewater treatment plant and lagoons are located down gradient from all of the PWS wells and are located outside of the inventory region.

Irrigation ditches/ canals are located throughout the inventory region. In fact, Owen Ditch flows through Dillon. If unlined, these ditches can transport contaminants near the wells and allow water to leach into the underlying alluvial aquifer.

Underground storage tanks (USTs) and leaking underground storage tanks (LUSTs) are located within the Dillon city limits and may release VOCs to Dillon wells 3 and 4. The USTs/LUSTs pose a high hazard to these wells. Spills of fertilizers, pesticides, volatile organic compounds (VOCs), and synthetic organic compounds (SOCs) could occur along the Union Pacific Railroad, Interstate 15, Montana Highway 41, and US Highway 91 within the inventory region. These potential contaminant sources pose a high hazard to wells 3 and 4.

No major petroleum pipelines or State Superfund sites were identified in the inventory region. Although

there maybe many more Class V Injection wells in Dillon, only one potential Class V injection well has been identified in connection with a hardware store.

SIGNIFICANT POTENTIAL CONTAMINANT SOURCES	INVENTORY REGION (WITH SURFACE WATER BUFFER COMBINED) See Figure 7	LOCATIONS	POTENTIAL CONTAMINANTS	HAZARD
Companies	Williams Feed & Fertilizer Plant	235 N Idaho		
Livestock Auction/ Cattle Ranches	Kon Peters Livestock Brokerage Zenchiku Land & Livestock Inc.	110 Fern Lane 4600 Carrigan Lane	Nitrates and pathogens	Infiltration into groundwater
Landscaping	Allen Landscape & Nursery Roxi's Greenhouse & Nursery	16 Pierce Drive 1200 North Lane	Nitrates	Infiltration of lawn care products into groundwater
Mines	Bald Mountain Mine Carl Robertson Gravel Pit Luzenac America Inc.	W. of Dillon E. of Dillon 790 N Montana St	VOCs, metals, inorganics	Leaching to groundwater
Roadway Transportation	Montana State Hwy 41	Dillon	VOCs, SOCs, nitrates	Accidental spills
Railway	Union Pacific Railroad	W. side of Dillon	VOCs, SOCs, nitrates	Accidental spills
Stormwater Discharges	Class V Injection Wells	Locations not determined	VOCs, SOCs, metals	Infiltration of contaminated water into groundwater
Landfills	Inactive Beaverhead County Landfill	W. of Dillon	VOCs, SOCs, metals, nitrates, pathogens	Effluent leaching to groundwater

Note: Septic Density is based upon population numbers of 2000 census with one septic system per 2.5 persons.

The hazard rating associated with private septic systems is determined on the basis of density of these systems. The Hazard is described as being High with >300/mile², Moderate with 50-300/mile², and Low with <50/mile².

Land Use is based upon the USGS Landcover dataset (2000)

UST/LUST, hazardous waste, and other information was provided by DEQ and NRIS

Business listings came from telephone directories / databases and other public sources. It does not indicate that these businesses are current polluters, but is simply listing them as potential contaminant sources based on experience with and the chemicals handled by similar types of businesses.

Inventory Results/ Recharge/Watershed Region

The recharge region for the Dillon wells is contained within the Beaverhead Watershed ([Figure 12](#)). In addition to the potential contaminant sources identified in the inventory region, there are numerous gold, silver, copper, lead, zinc, manganese, talc, and asbestos mines located in the Recharge/ Watershed Region. Not all of these mines are active. A list of these mine sites is included in Appendix D.

Inventory Update

The certified operator should update the inventory every year. Changes in land uses or potential contaminant sources will be noted and additions made as needed. The complete inventory will be submitted to DEQ every five years to ensure the source water delineation and assessment report remains current.

Inventory Limitations

The potential contaminant inventory was conducted using various databases to acquire readily available information. Information was also obtained where possible, from individuals familiar with the City of Dillon. Consequently, unregulated activities or unreported contaminant releases may have been overlooked. The use of multiple sources of information, however, should ensure that the major threats to the Dillon wells have been identified.

CHAPTER 4 SUSCEPTIBILITY ASSESSMENT

Susceptibility is the potential for a public water supply to draw water contaminated by inventoried sources at concentrations that would pose concern. Susceptibility is assessed in order to prioritize potential pollutant sources for management actions by local entities, in this case Dillon.

The goal of Source Water Management is to protect the source water by 1) controlling activities in the control zone, 2) managing significant potential contaminant sources in the Inventory Region, and 3) ensuring that land use activities in the Recharge Region pose minimal threat to the source water. Management priorities in the Inventory Region are determined by ranking the significant potential contaminant sources identified in the previous chapter according to susceptibility. Alternative management approaches that could be pursued by the Dillon to reduce susceptibility are recommended.

Susceptibility is determined by considering the hazard rating for each potential contaminant source and the existence of barriers that decrease the likelihood that contaminated water will flow to Dillon's well(s) (Table 7). Hazard is rated by the proximity of a potential contaminant source to the well(s). Susceptibility ratings are presented individually for each significant potential contaminant source and each associated contaminant (Table 8). The susceptibility of each well to each potential contaminant source is assessed separately.

Table 7. Relative susceptibility to specific contaminant sources as determined by hazard and the presence of barriers.

	High Hazard	Moderate Hazard	Low Hazard
No Barriers	Very High Susceptibility	High Susceptibility	Moderate Susceptibility
One Barrier	High Susceptibility	Moderate Susceptibility	Low Susceptibility
Multiple Barriers	Moderate Susceptibility	Low Susceptibility	Very Low Susceptibility

PWS Monitoring Waivers

Due to the numerous regulated chemicals that are used in the Dillon area, it does not appear that Dillon is eligible for monitoring waivers.

Summary

The Dillon PWS Source Water Delineation and Assessment Report was prepared to assist the City of Dillon to protect their four PWS wells. The report provides information concerning the aquifer that supplies water to Dillon's wells, identifies the control zones, inventory region (expanded to include the surface water buffer), and within each of these protection areas identifies the significant potential contaminants that may impact the PWS wells. Management recommendations that indicate how significant potential contaminant sources could be better managed to prevent impacts to Dillon's well are provided in Table 8.

The next phase of source water protection for Dillon would be for the City to take the information presented in this report and use it to continue development of a Source Water Protection Plan. The Source Water Protection Plan would clearly identify: 1) strategies to reduce the likelihood of contaminant releases within the inventory region, 2) the procedures to follow in the event that any of the Dillon wells become threatened by regulated contaminants, and 3) identify alternate sources of drinking water.

Table 8. Susceptibility assessment for significant potential contaminant sources in the Dillon PWS Control Zone and Inventory Region.

POTENTIAL CONTAMINANT SOURCES INVENTORY REGION (WITH SURFACE WATER BUFFER COMBINED) SEE FIGURE 7	POTENTIAL CONTAMINANTS	HAZARD	HAZARD RATING	BARRIERS	SUSCEPTIBILITY	MANAGEMENT RECOMMENDATIONS
<p>USTs: Dillon Exchange Building Dietrich's College Exxon Fast Break #414 Skone & Connors Seed Inc. County Courthouse Safeway AmeriGas Western Montana College Owen Trucking</p> <p>LUSTs: Co-op Supply, Inc. Town Pump Inc. (0160664) Town Pump Inc. #2 (0360664) Rocky Mountain Supply The Mini Inc. V-M Petroleum Bergeson Tank Chris's Chevron</p> <p>Big Sky Truck Stop</p>	<p>For all USTs VOCs</p> <p>For all LUSTs VOCs</p>	Migration of VOCs into groundwater	<p>High, all are in 1-year TOT</p> <p>High, rest are in 1-year TOT</p> <p>Moderate in 3-year TOT</p>	<p>Proper well construction; Leak detection systems; secondary containment</p> <p>Proper well construction</p> <p>Proper well construction; dilution</p>	<p>Moderate</p> <p>High</p> <p>Low</p>	<p>Conduct periodic operation and maintenance inspections</p> <p>Continue remediation efforts and groundwater monitoring</p> <p>Continue to monitor groundwater</p>
<p>Roadway Transportation Montana State Hwy 41</p>	VOCs, SOCs, nitrates	Accidental spills	High	Proper well construction	High	Spill Response Plan
<p>Railway Union Pacific Railroad</p>	VOCs, SOCs, nitrates	Accidental spills	High	Proper well construction	High	Spill Response Plan
<p>Landfills Inactive Beaverhead County</p>	VOCs, SOCs, metals, nitrates,	Effluent leaching to groundwater	High	Groundwater monitoring;	Moderate	Continue to monitor groundwater

Table 8. Susceptibility assessment for significant potential contaminant sources in the Dillon PWS Control Zone and Inventory Region.

POTENTIAL CONTAMINANT SOURCES INVENTORY REGION (WITH SURFACE WATER BUFFER COMBINED) SEE FIGURE 7	POTENTIAL CONTAMINANTS	HAZARD	HAZARD RATING	BARRIERS	SUSCEPTIBILITY	MANAGEMENT RECOMMENDATIONS
Landfill	pathogens			groundwater flow direction & gradient		
Agricultural Land 74 % Land cover	Nitrates and pathogens	Spills, over application, surface runoff leaching to groundwater	High	Proper well construction	Moderate	BMPs
Farm/Ranch Suppliers Montana Ag Products	Nitrates	Accidental spills of agricultural chemicals leaching into groundwater	High	Proper well construction	Moderate	Spill Response Plan BMPs
Landscaping Allen Landscape & Nursery Roxi's Greenhouse & Nursery	Nitrates	Infiltration of lawn care products into groundwater	High	Proper well construction; groundwater flow direction	Moderate	Spill Response Plan BMPs
Municipal Sewer 22.6% of area	Nitrates and pathogens	Main line breaks contaminated water mixing with groundwater	Moderate	Proper well construction; periodic sewer line upgrades	Low	Periodic inspections
Large Capacity Septic Systems Big Sky Truck Stop	Nitrates and pathogens	Effluent leaching to groundwater	Moderate	Proper well construction; dilution; natural	Low	Proper maintenance
Septic Systems Septic density 60.8% low Hazard	Nitrates and pathogens	Effluent leaching to groundwater	Low	Proper well construction	Low	Proper maintenance
Livestock Auction/ Cattle Ranches Kon Peters Livestock Brokerage Zenchiku Land & Livestock Inc.	Nitrates and pathogens	Infiltration into groundwater	Moderate	Proper well construction	Low	BMPs
Mines Bald Mountain Mine Carl Robertson Gravel Pit Luzenac America Inc.	VOCs, metals, inorganics	Leaching to groundwater	Low	Dilution	Low	Revegetation Tailings management

Table 8. Susceptibility assessment for significant potential contaminant sources in the Dillon PWS Control Zone and Inventory Region.

POTENTIAL CONTAMINANT SOURCES INVENTORY REGION (WITH SURFACE WATER BUFFER COMBINED) SEE FIGURE 7	POTENTIAL CONTAMINANTS	HAZARD	HAZARD RATING	BARRIERS	SUSCEPTIBILITY	MANAGEMENT RECOMMENDATIONS
Stormwater Discharges Class V Injection Wells	VOCs, SOCs, metals	Infiltration of contaminated water into groundwater	Unknown at this time	Not evaluated	Unknown at this time	Work with EPA to identify locations and appropriate response

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GLOSSARY*

Acute Health Effect. A negative health effect in which symptoms develop rapidly.

Alkalinity. The capacity of water to neutralize acids.

Aquifer. A water-bearing layer of rock or sediment that will yield water in usable quantity to a well or spring.

Barrier. A physical feature or management plan that reduces the likelihood of contamination of a water source from a potential contaminant source

Best Management Practices (BMPs). Methods for various activities that have been determined to be the most effective, practical means of preventing or reducing non-point source pollution.

Biennial Reporting System (BRS). An EPA database that contains information on hazardous waste sites. The data can be accessed through the EPA Envirofacts website.

Chronic Health Effect. A negative health effect in which symptoms develop over an extended period of time.

Class V Injection Well. Any pit or conduit into the subsurface for disposal of waste waters. The receiving unit for an injection well typically represents the aquifer, or water-bearing interval.

Coliform Bacteria. A general type of bacteria found in the intestinal tracts of animals and humans, and also in soils, vegetation and water. Their presence in water is used as an indicator of pollution and possible contamination by pathogens.

Community. A town, neighborhood or area where people live and prosper.

Comprehensive Environmental Cleanup and Responsibility Act (CECRA). Passed in 1989 by the Montana State Legislature, CECRA provides the mechanism and responsibility to clean up hazardous waste sites in Montana.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Enacted in 1980. CERCLA provides a Federal “Superfund” to clean up uncontrolled or abandoned hazardous-waste sites as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment. Through the Act, EPA was given power to seek out those parties responsible for any release and assure their cooperation in the cleanup.

Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS). A database that provides information about specific sites through the EPA Envirofacts website.

Confined Animal Feeding Operation (CAFO). Any agricultural operation that feeds animals within specific areas, not on rangeland. Certain CAFOs require permits for operation.

Confined Aquifer. A fully saturated aquifer overlain by a confining unit such as a clay layer. The static water level in a well in a confined aquifer is at an elevation that is equal to or higher than the base of the

overlying confining unit.

Confining Unit. A geologic formation present above a confined aquifer that inhibits the flow of water and maintains the pressure of the ground water in the aquifer. The physical properties of a confining unit may range from a five-foot thick clay layer to shale that is hundreds of feet thick.

Delineation. The process of determining and mapping source water protection areas.

Glacial. Of or relating to the presence and activities of ice or glaciers. Also, pertaining to distinctive features and materials produced by or derived from glaciers.

Geographic Information Systems (GIS). A computerized database management and mapping system that allows for analysis and presentation of geographic data.

Hardness. Characteristic of water caused by presence of various calcium and magnesium salts. Hard water may interfere with some industrial processes and prevent soap from lathering.

Hazard. A relative measure of the potential of a contaminant from a facility or associated with a land use to reach the water source for a public water supply. The location, quantity and toxicity of significant potential contaminant sources determine hazard.

Hydraulic Conductivity. A constant number or coefficient of proportionality that describes the rate water can move through an aquifer material.

Hydrology. The study of water and how it flows in the ground and on the surface.

Hydrogeology. The study of geologic formations and how they effect ground water flow systems.

Inventory Region. A source water management area for ground water systems that encompasses the area expected to contribute water to a public water supply within a fixed distance or a specified three year ground water travel time.

Lacustrine. Pertaining to, produced by, or formed in a lake or lakes.

Leaking Underground Storage Tank (LUST). A release from a UST and/or associated piping into the subsurface.

Maximum Contaminant Level (MCL). Maximum concentration of a substance in water that is permitted to be delivered to the users of a public water supply. Set by EPA under authority of the Safe Drinking Water Act to establish concentrations of contaminants in drinking water that are protective of human health.

Montana Bureau of Mines and Geology – Ground Water Information Center (MBMG/GWIC). The database of information on all wells drilled in Montana, including stratigraphic data and well construction data, when available.

Montana Pollutant Discharge Elimination System (MPDES). A permitting system that utilizes a database to track entities that discharge wastewater of any type into waters of the State of Montana.

National Pollutant Discharge Elimination System (NPDES). A national permitting system that utilizes a

database to track entities that discharge wastewater into waters of the United States.

Nitrate. An important plant nutrient and type of inorganic fertilizer that can be a potential contaminant in water at high concentrations. In water the major sources of nitrates are wastewater treatment effluent, septic tanks, feed lots and fertilizers.

Nonpoint-Source Pollution. Pollution sources that are diffuse and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet. Examples of nonpoint- source pollution include agriculture, forestry, and run-off from city streets. Nonpoint sources of pollution, such as the use of herbicides, can concentrate low levels of these chemicals into surface and/or ground waters at increased levels that may exceed MCLs.

Pathogens. A microorganism typically found in the intestinal tracts of mammals, capable of producing disease.

Permit Compliance System (PCS). An EPA database that provides information on the status of required permits for specific activities for specific facilities. The data can be accessed through the EPA Envirofacts website.

Phase II (and IIB) Rules. EPA updated or created legal limits on 38 contaminants. The rules became effective July 30, 1992 and January 1, 1993. Some of these contaminants are frequently-applied agricultural chemicals such as nitrate and others are industrial solvents.

Phase V Rule. EPA set standards for 23 contaminants in addition to those addressed by the Phase II Rules. The Phase V Rule became effective January 17, 1994. Some of these contaminants include inorganic chemicals such as cyanide and other Phase V contaminants are pesticides that enter water supplies through run-off from fields where farmers have applied them or by leaching through the soil into ground water. Six are probable cancer-causing agents. Others can cause liver and kidney damage, or problems of the nervous system and brain.

Point Source. A stationary location or a fixed facility from which pollutants are discharged. This includes any single identifiable source of pollution, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fracture, container, rolling stock (tanker truck), or vessel or other floating craft, from which pollutants are or may be discharged.

Pollutant. Generally, any substance introduced into the environment that adversely affects the usefulness of a resource (e.g. groundwater used for drinking water).

Public Water System (PWS). A system that provides water for human consumption through at least 15 service connections or regularly serves 25 individuals.

Pumping Water Level. Water level elevation in a well when the pump is operating.

Recharge Region. A source water management region that is generally the entire area that could contribute water to an aquifer used by a public water supply. Includes areas that could contribute water over long time periods or under different water usage patterns.

Resource Conservation and Recovery Act (RCRA). Enacted by Congress in 1976. RCRA's primary

goals are to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner.

Resource Conservation and Recovery Information System (RCRIS). Is a database that provides information about specific sites through the EPA Envirofacts website.

Secondary Maximum Contaminant Levels (SMCL). The maximum concentration of a substance in water that is recommended to be delivered to users of a public water supply based on aesthetic qualities. SMCLs are non-enforceable guidelines for public water supplies, set by EPA under authority of the Safe Drinking Water Act. Compounds with SMCLs may occur naturally in certain areas, limiting the ability of the public water supply to treat for them.

Section Seven Tracking System (SSTS). SSTS is an automated system EPA uses to track pesticide producing establishments and the amount of pesticides they produce.

Source Water. Any surface water, spring, or ground water source that provides water to a public water supply.

Source Water Delineation and Assessment Report (SWDAR). A report for a public water supply that delineates source water protection areas, provides an inventory of potential contaminant sources within the delineated areas, and evaluates the relative susceptibility of the source water to contamination from the potential contaminant sources under “worst-case” conditions.

Source Water Protection Areas. For surface water sources, the land and surface drainage network that contributes water to a stream or reservoir used by a public water supply. For ground water sources, the area within a fixed radius or three-year travel time from a well, and the land area where the aquifer is recharged.

Spill Response Region. A source water management area for surface water systems that encompasses the area expected to contribute water to a public water supply within a fixed distance or a specified four-hour water travel time in a stream or river.

Standard Industrial Classification (SIC) Code. A method of grouping industries with similar products or services and assigning codes to these groups.

Static Water Level (SWL). Water level elevation in a well when the pump is not operating.

Susceptibility (of a PWS). The relative potential for a PWS to draw water contaminated at concentrations that would pose concern. Susceptibility is evaluated at the point immediately preceding treatment or, if no treatment is provided, at the entry point to the distribution system.

Synthetic Organic Compounds (SOC). Man made organic chemical compounds (e.g. herbicides and pesticides).

Total Dissolved Solids (TDS). The dissolved solids collected after a sample of a known volume of water is passed through a very fine mesh filter.

Total Maximum Daily Load (TMDL). The total pollutant load to a surface water body from point, nonpoint, and natural sources. The TMDL program was established by section 303(d) of the Clean Water

Act to help states implement water quality standards.

Toxicity. The quality or degree of being poisonous or harmful to plants, animals, or humans.

Toxicity Characteristic Leachate Procedure. A test designed to determine whether a waste is hazardous or requires treatment to become less hazardous.

Toxic Release Inventory (TRI). An EPA database that compiles information about permitted industrial releases of chemicals to air and water. Information about specific sites can be obtained through the EPA Envirofacts website.

Transmissivity. A number that describes the ability of an aquifer to transmit water. The transmissivity is determined by multiplying the hydraulic conductivity time the aquifer thickness.

Turbidity. The cloudy appearance of water caused by the presence of suspended matter.

Unconfined Aquifer. An aquifer containing water that is not under pressure. The water table is the top surface of an unconfined aquifer.

Underground Storage Tanks (UST). A tank located at least partially underground and designed to hold gasoline or other petroleum products or chemicals, and the associated plumbing system.

Volatile Organic Compounds (VOC). Chemicals such as petroleum hydrocarbons and solvents or other organic chemicals which evaporate readily to the atmosphere.

Watershed. The land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common delivery point.

* With the exception of the definitions for Lacustrine, Phase II and Phase V Rules, and Standard Industrial Classification Code, definitions were adapted from EPA's Term References System (formerly known as Glossary of Selected Terms and Abbreviations) which can be found at:

<http://www.epa.gov/trs/index.htm>

The definitions of glacial and lacustrine were taken from the Glossary of Geology by Robert L. Bates and Julia A. Jackson.

The definitions for Phase II and Phase V Rules were adapted from:

<http://www.epa.gov/OGWDW/source/therule.html#PhaseII>

<http://www.epa.gov/OGWDW/source/therule.html#PhaseV>

The definition for Standard Industrial Classification Code was adapted from:

[EPA/Office of Enforcement and Compliance Assurance: Guide to Environmental Issues: Glossary of Terms & Acronyms Term Detail](#)

APPENDICES

APPENDIX A

Well Logs

APPENDIX B

PWS Site Plan

APPENDIX C

Time-of-Travel Equations

APPENDIX D

Potential Contaminant Sources in the Dillon Inventory and
Recharge/ Watershed Regions

APPENDIX A

WELL LOGS

**Montana Bureau of Mines and Geology -- Ground-water Information Center
Site Report for CITY OF DILLON * WELL 01**

Location Information

GWIC Id149185	Source of DataQW/GW4
Location (TRS)07S 09W 23 BDAA	Latitude (dd)45.2136
County (MT)BEAVERHEAD	Longitude (dd)-112.6722
DNRC Water Right88185	GeomethodNot Reported
PWS Id00201003	Datum1927
BlockNot Reported	AdditionNot Reported
LotNot Reported	SubdivisionNot Reported
Certificate of SurveyNot Reported	Type Of SiteWELL

Well Construction and Performance Data (measurements are reported below land surface)

Total Depth (ft)124.00	How DrilledNot Reported
Static Water Level (ft)35.00	Driller's NameNot Reported
Pumping Water Level (ft)	Driller LicenseNot Reported
Yield (gpm)1075.00	Completion DateMar 26, 1948
Test TypePUMP	Special ConditionsNone Reported
Test Duration	Is Well Flowing?No
Drill Stem Setting (ft)	Shut-In Pressure
Recovery Water Level (ft)	Well/Water UsePUBLIC WATER SUPPLY
Recovery Time (hrs)	Geology/AquiferI10ALVM

Hole Diameter Information

No hole diameter records were found.

Casing Information

From	To	Dia	Description
0.0	124.0	10.0	STEEL

Annular Seal Information

No annular seal records were found.

Completion Information

No completion records were found.

Lithology Information

From	To	Description
0.0	12.0	SURFACE DIRT AND BROKEN ROCK
12.0	50.0	YELLOW CLAY
50.0	70.0	GRAVEL AND SAND
70.0	95.0	YELLOW CLAY

These data represent the contents of the GWIC databases at the Montana Bureau of Mines and Geology at the time and date of the retrieval. The information is considered unpublished and is subject to correction and review on a daily basis. The Bureau warrants the accurate transmission of the data to the original end user. Retransmission of the data to other users is discouraged and the Bureau claims no responsibility if the material is retransmitted. Note: non-reported casing, completion, and lithologic records may exist in paper files at GWIC.

Montana Bureau of Mines and Geology -- Ground-water Information Center
Site Report for CITY OF DILLON * WELL 02

Location Information

GWIC Id151329	Source of DataLOG/QW
Location (TRS)07S 09W 23 BDAAA	Latitude (dd)45.2141
County (MT)BEAVERHEAD	Longitude (dd)-112.6704
DNRC Water RightNot Reported	GeomethodTRS-TWN
PWS Id00201004	Datum1927
BlockNot Reported	AdditionNot Reported
LotNot Reported	SubdivisionNot Reported
Certificate of SurveyNot Reported	Type Of SiteWELL

Well Construction and Performance Data (measurements are reported below land surface)

Total Depth (ft)83.50	How DrilledCHURN DRILL
Static Water Level (ft)46.00	Driller's NameHOLLENSTEINER
Pumping Water Level (ft)70.00	Driller LicenseNot Reported
Yield (gpm)550.00	Completion DateJan 28, 1960
Test TypePUMP	Special ConditionsNone Reported
Test Duration5.00	Is Well Flowing?No
Drill Stem Setting (ft)	Shut-In Pressure
Recovery Water Level (ft)	Well/Water UsePUBLIC WATER SUPPLY
Recovery Time (hrs)	Geology/Aquifer110ALVM

Hole Diameter Information

No hole diameter records were found.

Casing Information

From	To	Dia	Description
-2.0	83.5	12.0	STEEL

Annular Seal Information

No annular seal records were found.

Completion Information

From	To	Dia	Description
50.0	70.0	12.0	3/8 KNIFE

Lithology Information

From	To	Description
0.0	12.0	SURFACE DIRT & BROKEN ROCK
12.0	50.0	YELLOW CLAY
50.0	70.0	GRAVEL SAND WATER BEARING
70.0	95.0	YELLOW CLAY SOME WATER IN CLAY FROM 93-95

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**Montana Bureau of Mines and Geology -- Ground-water Information Center
Site Report for CITY OF DILLON * WELL 03**

Location Information

GWIC Id109444	Source of DataLOG
Location (TRS)07S 08W 18 CDCC	Latitude (dd)45.2186
County (MT)BEAVERHEAD	Longitude (dd)-112.6347
DNRC Water RightNot Reported	GeomethodNot Reported
PWS Id00201002	Datum1927
Block5	AdditionDILLON ORIGINAL
Lot11	SubdivisionNot Reported
Certificate of SurveyNot Reported	Type Of SiteWELL

Well Construction and Performance Data (measurements are reported below land surface)

Total Depth (ft)60.00	How DrilledCHURN DRILL
Static Water Level (ft)17.00	Driller's NameHOLLENSTEINER
Pumping Water Level (ft)24.00	Driller LicenseWWC009
Yield (gpm)1000.00	Completion DateMar 02, 1963
Test TypePUMP	Special ConditionsNone Reported
Test Duration8.00	Is Well Flowing?No
Drill Stem Setting (ft)	Shut-In Pressure
Recovery Water Level (ft)	Well/Water UsePUBLIC WATER SUPPLY
Recovery Time (hrs)	Geology/Aquifer111ALVM

Hole Diameter Information

No hole diameter records were found.

Casing Information

From	To	Dia	Description
-2.0	50.0	14.0	STEEL

Annular Seal Information

No annular seal records were found.

Completion Information

From	To	Dia	Description
20.0	46.0	14.0	1/4X2 PERFS

Lithology Information

From	To	Description
0.0	8.0	CLAY & SURFACE DIRT
8.0	32.0	SAND GRAVEL SMALL COBBLES
32.0	36.0	CLAYBOUND GRAVEL
36.0	46.0	COARSE SANDS & FINE GRAVEL
46.0	60.0	CLAYBOUND GRAVEL & SAND

These data represent the contents of the GWIC databases at the Montana Bureau of Mines and Geology at the time and date of the retrieval. The information is considered unpublished and is subject to correction and review on a daily basis. The Bureau warrants the accurate transmission of the data to the original end user. Retransmission of the data to other users is discouraged and the Bureau claims no responsibility if the material is retransmitted. Note: non-reported casing, completion, and lithologic records may exist in paper files at GWIC.

Montana Bureau of Mines and Geology -- Ground-water Information Center
Site Report for CITY OF DILLON * WELL 04 (CITY PARK)

Location Information

GWIC Id151327	Source of DataLOG
Location (TRS)07S 08W 19 BADDCA	Latitude (dd)45.2154
County (MT)BEAVERHEAD	Longitude (dd)-112.6297
DNRC Water RightW88188	GeomethodTRS-TWN
PWS Id00201006	Datum1927
BlockNot Reported	AdditionNot Reported
LotNot Reported	SubdivisionNot Reported
Certificate of SurveyNot Reported	Type Of SiteWELL

Well Construction and Performance Data (measurements are reported below land surface)

Total Depth (ft)80.00	How DrilledCABLE TOOL
Static Water Level (ft)9.00	Driller's NameBRIGGS
Pumping Water Level (ft)41.00	Driller LicenseWWC148
Yield (gpm)1130.00	Completion DateJun 20, 1973
Test TypeSWABBING	Special ConditionsNone Reported
Test Duration4.00	Is Well Flowing?No
Drill Stem Setting (ft)	Shut-In Pressure
Recovery Water Level (ft)	Well/Water UsePUBLIC WATER SUPPLY
Recovery Time (hrs)	Geology/Aquifer110ALVM

Hole Diameter Information

No hole diameter records were found.

Casing Information

From	To	Dia	Description
-2.0	80.0	16.0	STEEL

Annular Seal Information

No annular seal records were found.

Completion Information

From	To	Dia	Description
20.0	33.0	16.0	SLOT
64.0	72.0	16.0	SLOT

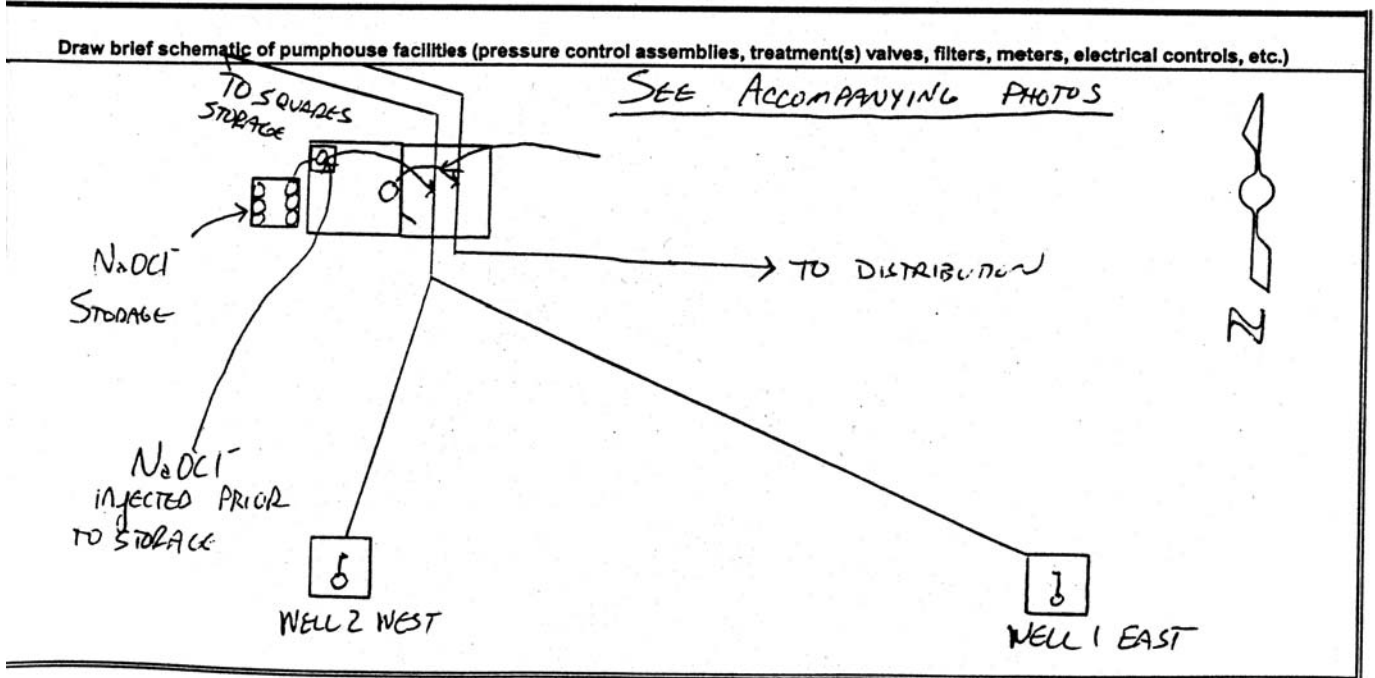
Lithology Information

From	To	Description
0.0	6.0	SOIL
6.0	20.0	SOIL & GRAVEL
20.0	25.0	SMALL GRAVEL & SAND (WATER)
25.0	33.0	GRAVEL & SAND (WATER)
33.0	64.0	CLAY
64.0	72.0	GRAVEL (WATER)
72.0	82.0	CLAY EMBEDDED GRAVEL

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APPENDIX B
PWS SITE PLAN

**PWS Site Plan For Dillon Wells 1 and 2
(Information from 2001 Sanitary Survey)**



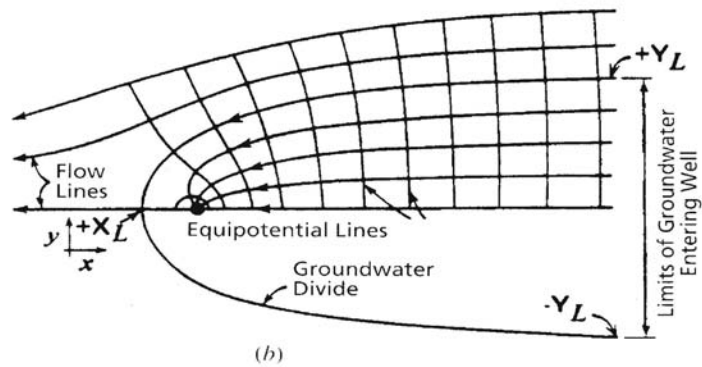
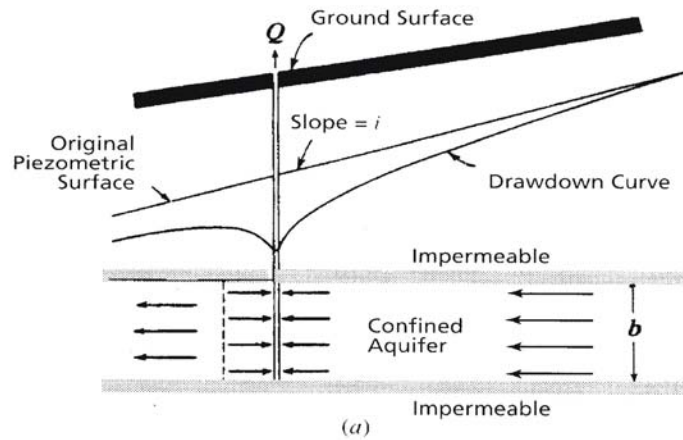
Due to their size, site maps for Dillon Wells 3 and 4 are available upon request.

APPENDIX C

Time-of-Travel Calculations

UNIFORM GROUNDWATER FLOW EQUATION

Flow to a well penetrating a confined aquifer having a sloping plane piezometric surface - vertical section and plan view (Todd, 1980).



$$\frac{-Y}{X} = \tan\left(\frac{2\pi Kbi}{Q} Y\right)$$

Uniform-Flow Equation

$$X_L = -\frac{Q}{2\pi Kbi}$$

Distance to
Down-Gradient
Null Point

$$Y_L = \pm \frac{Q}{2Kbi}$$

Boundary Limit

Legend:

- Pumping Well

Where:

- Q = Well Pumping Rate
- K = Hydraulic Conductivity
- b = Saturated Thickness
- i = Hydraulic Gradient
- $\pi = 3.1416$

TIME-OF-TRAVEL CALCULATION METHOD

The time of travel for water to move along a line parallel to the hydraulic gradient, from a point to a pumping well (EPA 1991).

$$T_x = \frac{n}{Ki} \left[X_L - \frac{Q}{2\pi Kbi} \ln \left(1 + \frac{2\pi kbi}{Q} X_L \right) \right]$$

T_x	=	travel time from point x to a pumping well
n	=	porosity
X_L	=	distance from pumping well over which groundwater travels in T_x
Q	=	discharge
K	=	hydraulic conductivity
b	=	aquifer thickness
i	=	hydraulic gradient

APPENDIX D
Potential Contaminant Sources In The
Dillon Inventory Region
&
Recharge/Watershed Region

APPENDIX E

Concurrence Letter